Remarks: Examination Report

It is submitted that with the amended Independent Claims 1, 6, 9, 12, and 16 herein, the rejections raised against the claims are overcome.

1. Section 1 of the Examination Report

The basis for rejection of Claims 1-13 and 16-17 under 35 U.S.C. 102(e) as being anticipated by Agee (U.S. Pat. No. 6,128,276) is noted.

Applicant submits that the above-recited step of providing for **CI modulation** of at least one data symbol onto a plurality of carrier signals as stated in the amended independent claim 1 (and hence, in the dependent claims 2-5), clearly presents a novel method that the prior-art references neither describe nor anticipate. CI modulation is now well-known by persons skilled in the art, due to the publication of over 100 conference and journal papers, and at least two textbooks. Thus, the amended independent claim 1 (and hence, the dependent claims 2-5) should be considered patentable under 35 U.S.C. 102.

Applicant submits that the above-recited modulator capable of redundantly modulating at least one information signal onto a plurality of the carrier signals wherein the improvement comprises at least one of the carrier-signal generator and the modulator being adapted to provide the modulated carrier signals with an incremental phase relationship that facilitates separation of multiple information signals modulated onto the same carrier signals by orthogonally positioning data-modulated pulse waveforms produced from a superposition of the carrier signals, as stated in the amended Independent Claims 6 and 9 (and thus dependent claims 7-8 and 10-11) clearly presents novel structure that the prior-art references neither describe nor anticipate. Thus, the amended independent claims 6 and 9 (and hence, the dependent claims 7-8 and 10-11) should be considered patentable under 35 U.S.C. 102.

Applicant submits that the above-recited receiver responsive to a plurality of CI-modulated carriers, as stated in the amended Independent Claim 16 (and thus dependent

claim 17) clearly presents novel structure that the prior-art references neither describe nor anticipate. Thus, the amended independent claim 16 (and hence, the dependent claim 17) should be considered patentable under 35 U.S.C. 102.

Specifically, the claimed invention recites CI modulation, which purposely uses interfering carriers to generate pulse waveforms that are localized in time. In particular, the specification (e.g., page 22, line 23 to page 23, line 5) describes the mathematical relationship necessary for linear phase shifts applied to carriers to orthogonally position data-modulated pulse waveforms formed from a superposition of the carriers.

Alternatively, Agee describes linearly independent non-orthogonal sets of spreading gains. Although orthogonal spreading gains may be employed in Agee (such as MC-CDMA codes), such prior-art orthogonal spreading gains, or codes, are structurally different than CI modulation (i.e., codes), and neither the prior-art orthogonal codes or Agee's non-orthogonal codes offer the notable advantages of CI codes, such as described in the recently published literature.

Since CI-modulated signals are notably different from prior-art multicarrier signals, the methods and systems for generating CI signals are also novel.

By providing incremental phase shifts to the carrier signals that map each information symbol into at least one pulse waveform resulting from a superposition of the carrier signals, the independent claims 1, 6, and 9 achieve the following unique benefits:

a. CI signals have lower peak-to-average power ratios (PAPR) than any other multicarrier waveform, such as described in D.A. Wiegandt and C. R. Nassar, "Peak-To-Average Power Reduction in High-Performance, High-Throughput OFDM via Pseudo-Orthogonal Carrier-Inteferometry Coding," in Proc. 2001 IEEE Pacific Rim Conference on Communications, Computers, and Signal Processing (PACRIM'01), Victoria, BC, August 26-28, 2001.

b. CI signals were shown to have the highest cross-correlation performance of any signal type (B.Natarajan , S.Das and D.Stevens, "Design of optimal complex spreading codes for DS-CDMA using an evolutionary approach," Proceedings of *IEEE Global Telecommunications Conference, GLOBECOM 2004*, Dallas, Nov. 2004).

c. CI is the only multicarrier waveform that can synthesize conventional single-carrier waveforms, such as DS-CDMA and TDMA signals (S.A. Zekavat, C.R. Nassar, S. Shattil, "High-Performance Wireless via the merger of CI chip-shaped DS-CDMA and oscillating-beam smart antenna arrays," EURASIP JASP 2004:9 (2004) 1376-1383)(B. Natarajan, C.R. Nassar, and S. Shattil, "Throughput enhancement in TDMA through carrier interferometry pulse shaping," in 2000 IEEE Vehicular Technology Conference, Boston, MA, Sept. 24-28, 2000).

d. CI signals enable a non-uniform distribution of interference in a dispersive medium (e.g., a multipath environment). This is due to how CI modulation maps data to orthogonal pulse waveforms. Thus, a delay spread of only a few pulse waveforms limits interference to a few neighboring pulses. This greatly simplifies multi-channel detection (e.g., multi-user detection).

Since CI modulation provides such important and unexpected benefits compared to any prior-art modulation scheme, the amended independent claims are submitted to be non-obvious, and thus, are also patentable under 35 U.S.C. 103.

No other prior-art reference produces pulse waveforms from superpositions of carriers. No other prior-art reference maps information symbols to pulse waveforms generated from multiple carriers. No other prior-art reference combines carriers in a way that produces signals that are orthogonal in time. Accordingly, no other prior-art reference generates multicarrier signals with complex carrier weights that map information symbols to pulse waveforms generated from superpositions of the carrier signals.

None of the prior-art references teach to generate pulse waveforms from superpositions of carrier signals. None of the prior-art references teach to combine carriers in a way that produces pulses that are orthogonal in time. None of the prior-art references teach to encode a multicarrier signal with complex weights that map information symbols to pulse waveforms generated from carrier superpositions.

Agee describes linearly independent non-orthogonal sets of spreading codes. Although Agee mentions that orthogonal sets of spreading codes may be used, there is no description of any type of orthogonal spreading code other than the well-known MC-CDMA codes, which are just binary Hadamard-Walsh codes, not linear-phase codes.

Neither Agee's linearly independent non-orthogonal codes, nor prior-art orthogonal codes, applied to a plurality of carriers are capable of orthogonally positioning data-modulated pulse waveforms produced from a superposition of the carrier signals. Thus, neither Agee, nor any other prior-art reference can provide the benefits of CI modulation.

1. Agee's multicarrier waveforms have high PAPR.
2. Agee's multicarrier waveforms have sub-optimal cross-correlation performance.
3. Agee's multicarrier waveforms cannot synthesize conventional single-carrier waveforms.
4. Agee's multicarrier waveforms uniformly distribute interference across other code spaces, making multi-channel detection highly complex.

Therefore, it should be appreciated that the schema described by the cited art is not the same as that claimed by the present invention. The present claims are therefore novel.

2. Section 2 of the Examination Report

The objection to Claims 14-15 is noted. Accordingly, as per the Examiner's recommendation, Claim 12 was rewritten to include limitations recited in Claims 14 and 15.

3. Section 3 of the Examination Report

The prior art references made of record and not relied upon have been studied, but are submitted to be less relevant than the relied-upon references.

4. Conclusion

The Applicant submits that every effort has been made to address the Examiner's objection and that the Application is now in condition to proceed to grant.

Very Respectfully,

Steve J. Shattil

4980 Meredith Way #201
Boulder, CO 80303
(720) 564-0691